SXT Mirror Segments Development

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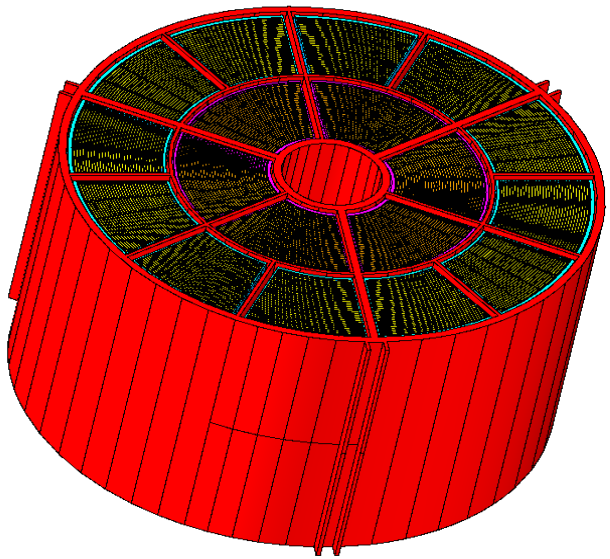
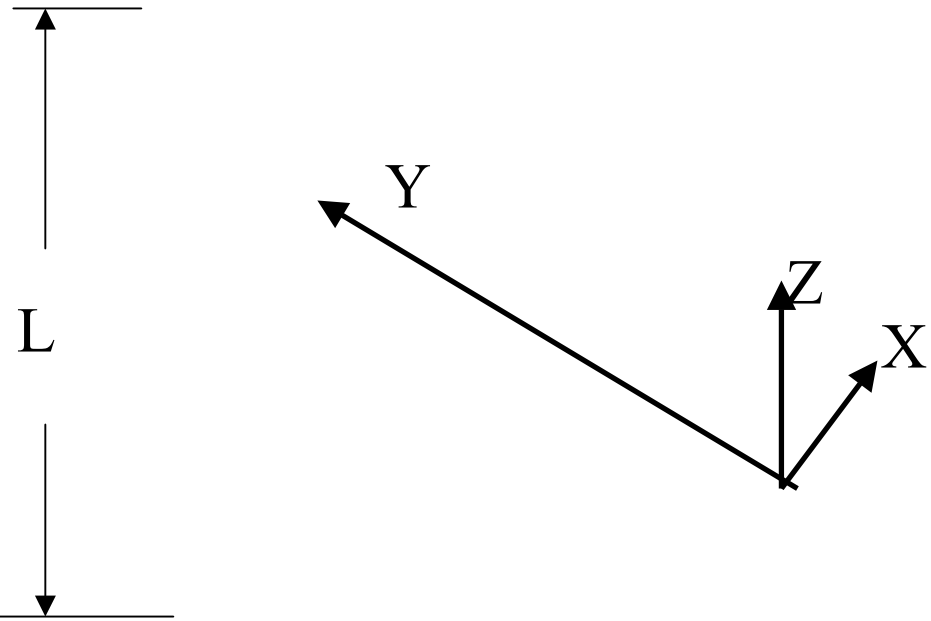
Con-X Telescope Construction

Fabrication and testing of Mirror Segments

Integration and Alignment of Mirror Segments



Definition of Mirror Segments



- Mirror Segments

$$r_p = r_{p0} + \tan\theta_p \bullet z + S_p \bullet \left(\frac{2z}{L}\right)^2 + O\left(\frac{2z}{L}\right)^3$$

$$r_s = r_{s0} + \tan\theta_s \bullet z + S_s \bullet \left(\frac{2z}{L}\right)^2 + O\left(\frac{2z}{L}\right)^3$$

- In the real world

$$\vartheta_s \approx 3\vartheta_p$$

$$S_s \approx S_p$$

- Con-X SXT Requirements

$$RMS\ (\vartheta_p, \vartheta_s) \le 20''$$

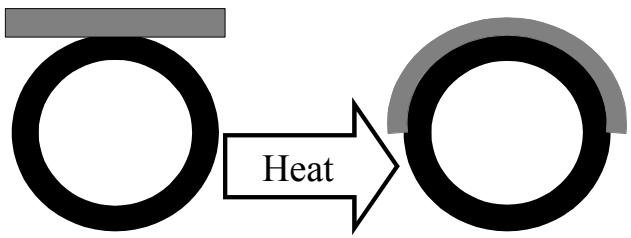
$$RMS\ (S_p) \le 0.3\,\mu m$$

$$RMS\ \left(O\left(\frac{2z}{L}\right)^3\right) \le 0.05\ \mu m$$

Mirror Segment Fabrication

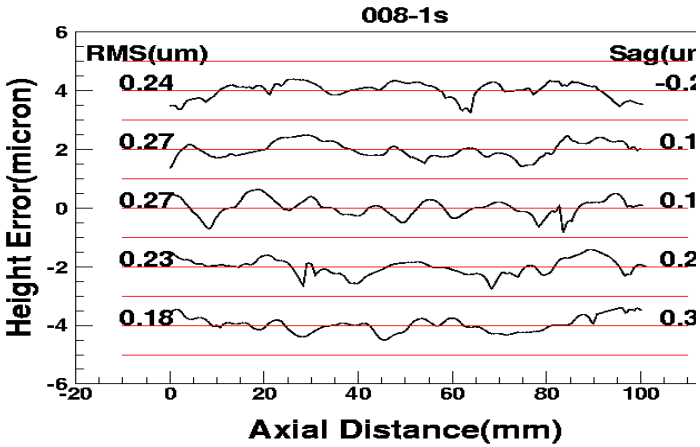
- Substrate Forming
  - 0.4mm Schott D263 Glass Sheet
  - Conical/Wolter-I Forming Mandrel
  - Heating Cycle
- Replication
  - Application of epoxy on Substrate
  - Mating of substrate and replication mandrel
  - Separation of replica from replication

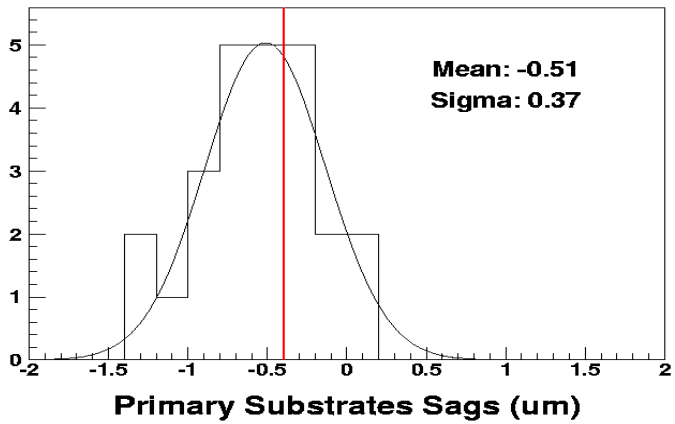
Forming Substrate



- Conical fused silica mandrel
- Mandrel surface treatment to prevent sticking
- Heating cycle
- Slumping onto the convex surface

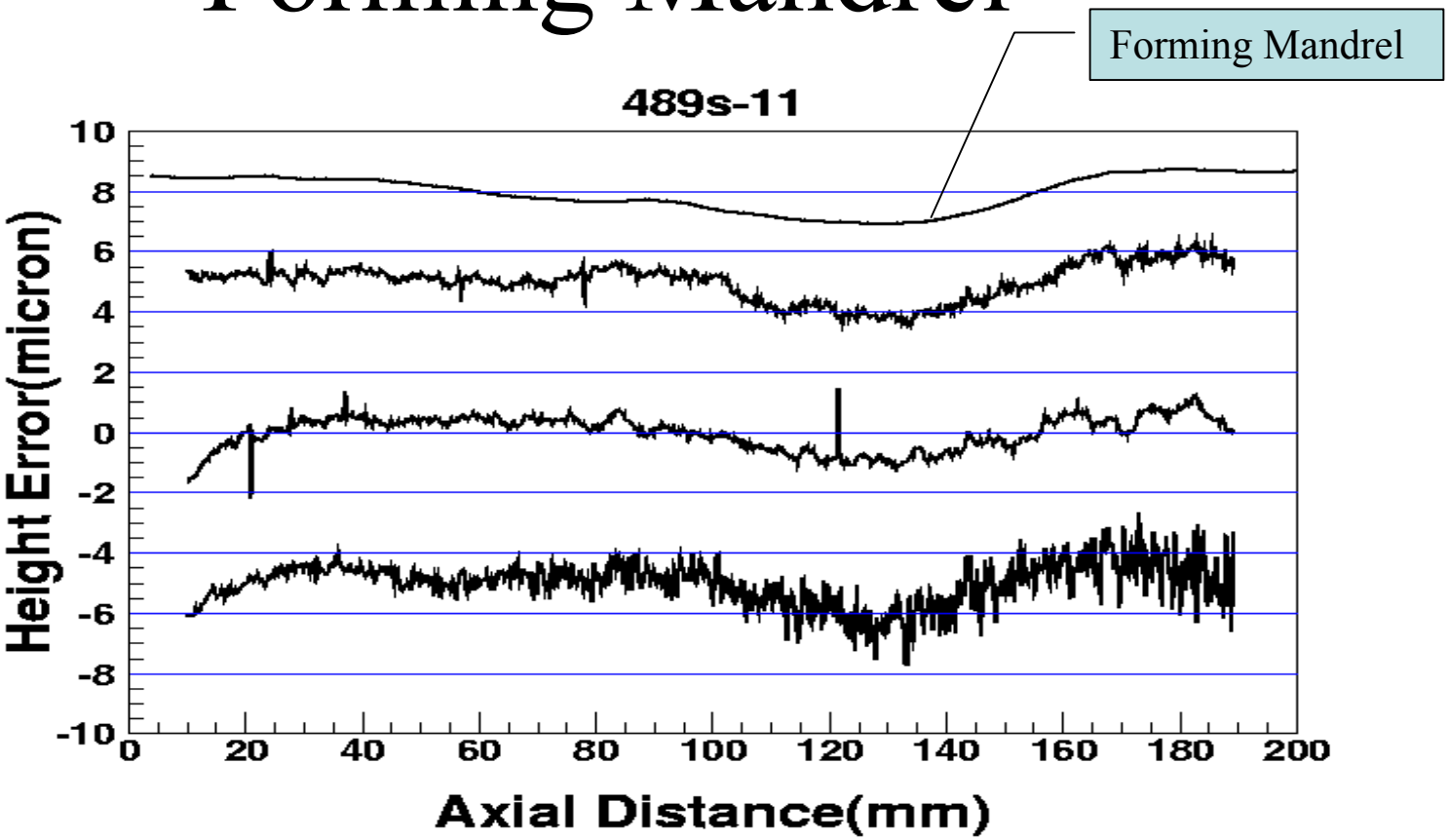
Substrate Quality



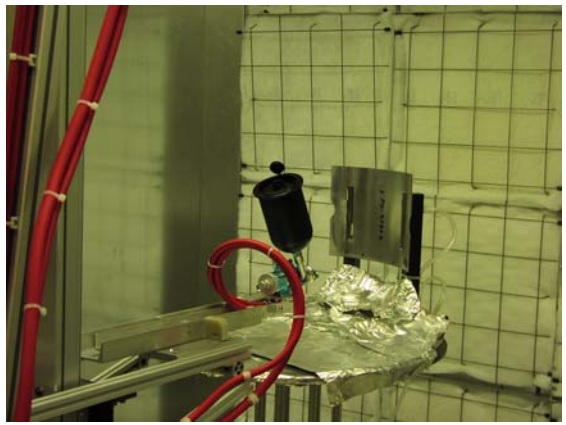


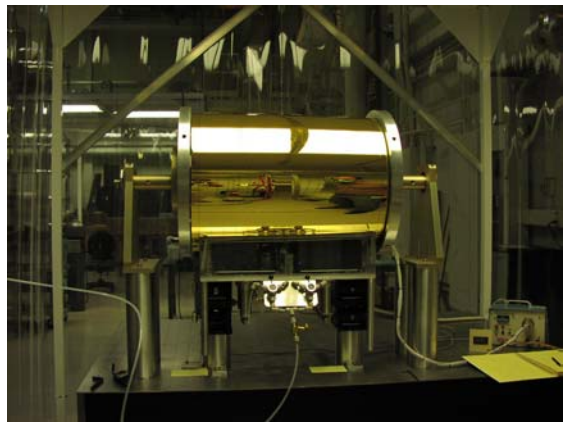
- Excellent conformance to forming mandrel
- Mid-frequency ripples RMS ~0.25 microns
- Excellent reproducibility/yield

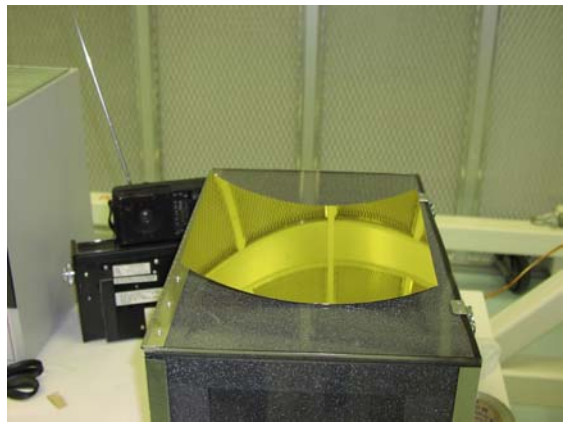
Comparison of Substrate and Forming Mandrel



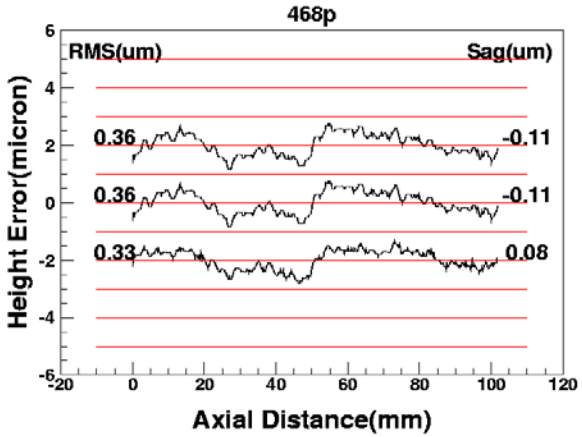
Replication

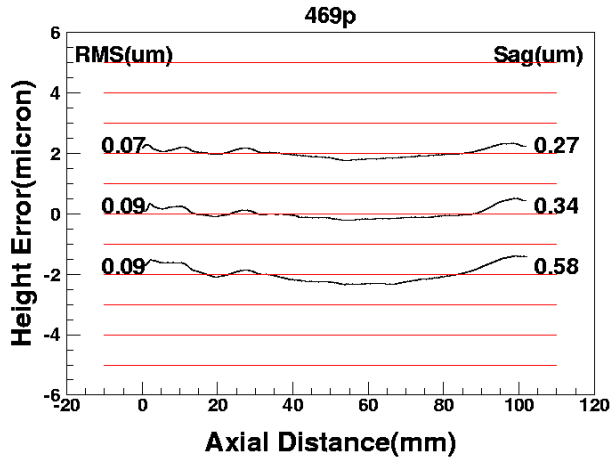


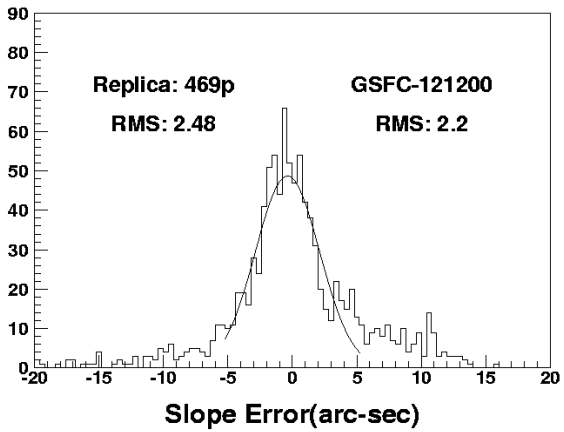




Fidelity of Replication







Microroughness

Mandrel: 3.6+/-0.4

Replica: 4.0+/-0.6

Pedigree of the Replica

Replica Characteristics	Forming Mandrel	Replication Mandrel
Average Radius	X	
Average Slope (Cone Angle)	X	
Sag	X	X
Axial Figure Error		X
Microroughness		X

Important Issues

- What is the cause of the ripples on the substrates: dust particles, defects on glass sheet, or glass buckling when slumping
- What's the extent to which stresses in the epoxy layer will distort the final mirror segment? This effect will eventually limit the size of the mirror segment
- Whose sag will the final replica take: the forming mandrel's or the replication mandrel's, or some combination of the two?

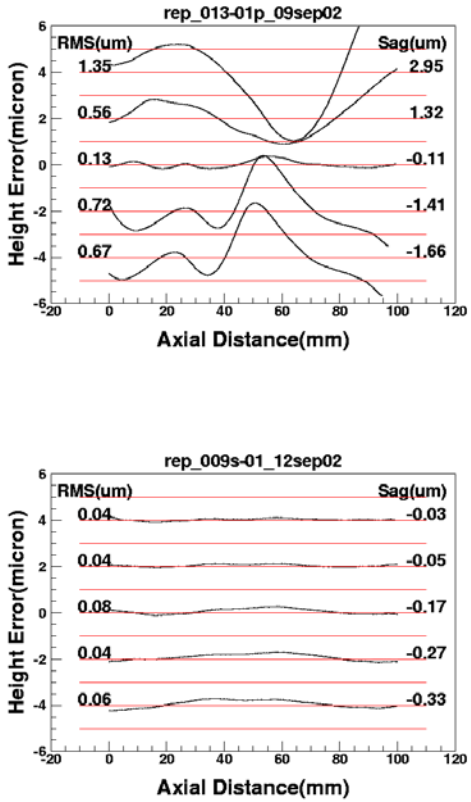
Summary of Development Status

- We have fabricated excellent substrates: both 100-mm and 200-mm in axial length
- Mirror segments with 100-mm axial lengths are very close to meeting Con-X/SXT requirements, replication mandrel quality dominating the error
- Mirror segments with 200-mm axial lengths are being replicated and studied, result expected in next few months

Development Status

Axial Length	Status	No. of Segments Needed for Con-X
10cm	Demonstrated	~30,000
20cm	Being worked on now, result expected by end of year	~15,000
30cm	Goal	~10,000

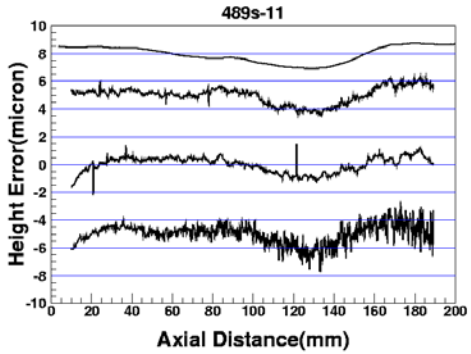
Effect of Dust on Replication

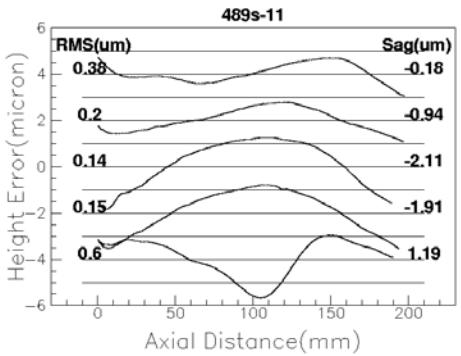


- Dust particles sandwiched between the substrate and the replication mandrel wreak havoc in the replication process
- Top Panel: a replica done without dust mitigation
- Bottom Panel: a replica done after dust mitigation

Replication of Large Mirrors

(Diameter: 50cm; Axial Length: 20cm)





- **Top Panel:** axial figures of a substrate
- **Bottom Panel:** axial figures of the replica
- The replica is severely distorted. Possible reasons: (1) epoxy stress, (2) dust particles during replication, (3) distortion during measurements